DOCUMENT RESUME

ED 063 268 SP 005 740

AUTHOR	Treffinger, Donald J.
TITLE	Improving Children's Creative Problem Solving Ability: Effects of Distribution of Training, Teacher Involvement, and Teacher's Divergent Thinking Ability on Instruction. Final Report.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-0-E-086
PUB DATE	Dec 71
GRANT	OEG-5-70-0029(509)
NOTE	79p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Creative Thinking; *Creativity; *Divergent Thinking; *Problem Solving; *Productive Thinking
IDENTIFIERS	Productive Thinking Program; Purdue Creativity Training Program; Torrance Tests of Creative Thinking

ABSTRACT

This report investigates improvement of pupils' creative thinking and problem-solving abilities through direct educational efforts. The sample consisted of 739 pupils and their teachers from 36 fifth grade classes in two Indiana public school systems. Five sub-tests from the Torrance Tests of Creative Thinking were administered to all teachers to determine their level of divergent thinking ability. A median split was then used to divide the teachers into a high group and a low group. Pupils assigned to PTP (Productive Thinking Program) and PCTP (Purdue Creativity Training Program) studied 16 instructional units over a period of 4-8 weeks. Teachers assigned to discussion treatments interacted with the pupils, discussing the materials and attempting to foster creative thinking and problem solving among pupils. Teachers assigned to non-discussion treatments distributed the materials and supervised the students, but had minimal interaction. Classes assigned to the control group continued their normal classroom activities with no special instructional treatment. All pupils were given pre-and post-tests. Results provided evidence that some creative thinking and problem solving abilities of fifth grade pupils can be positively influenced by deliberate instructional efforts. Three major problems are identified: a) difficulty in defining treatment, b) validity of teacher divergent thinking scores, and c) complexity of the construct of creativity. Further research is recommended. A 48-item bibliography, appendixes, tables and figures are included. (MJM)

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ED 063268

FINAL REPORT

Project Number 0-E-086

Grant Number OEG-5-70-0029 (509)

IMPROVING CHILDREN'S CREATIVE PROBLEM SOLVING ABILITY: THE EFFECTS OF DISTRIBUTION OF TRAINING, TEACHER INVOLVEMENT, AND TEACHER'S DIVERGENT THINKING ABILITY ON INSTRUCTION

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December 1971

The research reported herein was performed persuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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SP005740

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CHAPTER ONE:

INTRODUCTION AND STATEMENT OF PROBLEM

Can pupils' creative thinking and problem solving abilities be improved through direct educational efforts? This question has interested theorists and researchers in education and psychology for over two decades. A number of training programs have been developed which purport to facilitate creative problem solving abilities among elementary school pupils. These have included workbook activities (Myers and Torrance, 1965, 1966), guidebooks and creative problem solving courses (Davis, 1968; Parnes, 1967), recordings (Cunnington and Torrance, 1965; Torrance and Gupta, 1964), and educational radio programs (Feldhusen, Bahlke, and Treffinger, 1969). Nearly fifty different methods and techniques for promoting creative growth have been developed for use with children, adolescents, and adults (Treffinger and Gowan, 1971)

Amidst this profusion of methods, techniques, and programs, two have been the focus of a substantial amount of research at the elementary school level: the Purdue Creativity Training Program (Feldhusen, Treffinger, and Bahlke, 1970) and the Productive Thinking Program (Covington, Crutchfield, and Davies, 1966).

The Purdue Creativity Training Program (PCTP) consists of 28 audiotape presentations and stories, each accompanied by printed creative thinking exercises. The presentations convey a brief message concerning creative thinking and problem solving; the content of the stories (each ten to twelve minutes long) is historical, focussing on persons and events from American history. The exercises, utilizing the content of the stories, provide opportunities for the use of fluency, flexibility, and originality in drawing and writing.

Research evidence supporting the effectiveness of the PCTP has been provided in three recent investigations. The program was first utilized as an educational radio series, in which Feldhusen, Bahlke, and Treffinger (1969) found that instructed pupils' performance on creative thinking measures was significantly better than the performance of pupils who had not received the instruction. In a large study, involving pupils in 48 classrooms in grades four, five, and six, Feldhusen, Treffinger, and Bahlke (1971) reported that instructed pupils made significantly greater gains on several creative thinking measures and in language achievement than control pupils. The PCTP was also used in several fourth grade classes in an urban area in Georgia by Robinson (1969); she found that pupils in the instructed groups performed significantly better than matched groups of control children on several measures of creative thinking.

The Productive Thinking Program (PTP) is a programed instructional sequence, consisting of 16 lessons which purport to enhance creative thinking and problem solving abilities among pupils in grades five and six; it has also been utilized in several recent research studies. Covington and Crutchfield (1965), Wardrop et al., (1969),and Olton and Crutchfield (1969) have presented evidence that these instructional materials, particularly for pupils in grade five, have led to significant improvements in performance on measures of divergent thinking, problem solving, and attitudes towards creative thinking. Ripple and Dacey (1967) reported that eighth-grade pupils who had studied the PTP solved a criterion problem significantly faster than control pupils. Treffinger and Ripple (1968, 1969a) found that instructed pupils in grades four through seven expressed significantly more favorable attitudes about creative thinking than uninstructed pupils, although there were no significant differences on tests of verbal creative thinking abilities.

Although these studies have, in general, supported the effectiveness of the PCTP and the PTP, there are several major problems concerning their utilization, and the magnitude of their effects, which have not been solved. Treffinger and Ripple (1971) have identified three major areas in which further research is needed. Although their discussion focusing specifically on the PTP, these questions are also appropriate in reference to the PCTP. They are:

(1) What influence does active teacher particiaption, rather than self-instructional utilization, have on the effectiveness of the programs?

(2) What influence does distribution of training have on the effectiveness of the program?

(3) What criteria are influenced?

Each of these questions will be discussed briefly, since they provided the basis for the present investigation.

Active Teacher Participation. There have been no systematic investigations of the influence of active teacher participation on the effectiveness of the instructional program. Although the PTP was originally described (by Crutchfield and Covington, 1965) as a self-instructional program, teachers have been encouraged, in some studies, to discuss and supplement the lessons with their pupils. This teacher participation has not been included, however, as a factor in the design of the research; in addition, in some studies where teacher participation was utilized, other factors (such as the distribution of practice) were also allowed to vary from previous studies. For example, Treffinger and Ripple (1969a) used the lessons during a 16-day period, without teacher participation; Olton and

Crutchfield (1969) encouraged active teacher participation, but also used the materials over an eight-week period of instruction. Thus, it is impossible to determine whether differences in the results of the two studies might be influenced by teacher participation, distribution of practice, or both.

The PCTP has been used as a self-instructional program in the previous research. Teachers have only distributed the exercises and played the tapes for their pupils. It is important to consider, however, the possibility that active teacher participation in the instruction might lead to increased effectiveness. Recent research (Blount et al, 1967; Ryan, 1968) has indicated that active teacher involvement facilitates learning, even under programed instructional conditions.

The influence of teacher participation on the effectiveness of instruction in divergent thinking and problem solving may also be related to the teacher's own divergent thinking ability. Bahlke, Treffinger, and Feldhusen (1969) reported that there was a strong, positive correlation between the divergent thinking scores of 38 elementary school teachers and the mean divergent thinking scores of their pupils. Gallagher and Aschner (1963) also reported a similar relationship between teacher behavior which called for divergent thinking and pupils' divergent production. It seems, therefore, that any investigation of the influence of the teacher on instruction in creative problem solving must also consider the teacher's ability in divergent thinking.

Distribution of Practice. As indicated above, there has been variability from study to study, in the duration of the instructional period. Treffinger and Ripple (1968, 1969a) used the PTP on 16 consecutive school days. Wardrop et al (1969) used the 16 lessons in four weeks. Olton and Crutchfield (1969) used two lessons per week for an eight week period. No study has been conducted in which distribution of practice has been systematically varied as an experimental arrangement. The importance of such an experimental investigation is underscored by the recognition that, for long-term retention of complex material, research has generally supported distributed rather than massed practice (Travers, 1967). Cook (1936) reported that solutions to problems were retained better, over a considerable time period, when solved under distributed-practice conditions than under massed-practice conditions.

The 28 tapes in the PCTP have been used at the rate of 1, 2 or 3 lessons per week. No research has investigated the influence of variations in distribution of training with these materials.

Nature of the criteria. Davis (1966) has referred to the psychological literature on problem solving as "chaotic" because of the number and diversity of the criterion tasks that have been used. In addition, there

has been substantial criticism of tests of creative thinking, as they have been used in educational research (Wallach and Kogan, 1965; Wallach, 1968). Research on the effectiveness of PTP has also utilized many diverse criteria. Covington and Crutchfield (1965), and Wardrop et al (1969) found that instructed pupils performed significantly better than controls on "programed" problem solving tasks (see: Covington, 1969). Wardrop et al (1969) found, however, that there were no significant differences between instructed and control pupils on tests of fluency, flexibility, and originality in thinking; similar results were reported by Treffinger and Ripple (1968, 1969a) and by Ripple and Dacey (1967). Olton and Crutchfield (1969) reported on criteria derived from pupils' essays (number of ideas, number of problem solutions,and rated quality of responses). Ripple and Dacey (1967) used a behavioral criterion problem: Ss were presented with Maier's two string problem. Treffinger and Ripple (1968, 1969a) used paper-and-pencil problems. Research with the PCTP has utilized principally divergent thinking measures as criteria.

It seems necessary that research on instruction in creative problem solving should utilize multiple criteria, with criteria that are varied in a systematic fashion, in order to make generally valid statements about the extent and generality of the training. The importance of variations in outcome variables has been shown clearly by Tuckman et al (1968). They reported that, in training subjects to use short-cuts in solving problems, the effectiveness of training varied with the format of the criterion measures. The strongest training effects were found when criterion problems were similar in format to the training problems. As the criterion problems became less similar to the training problems, the effectiveness of the training diminished.

Utilization of Two Instructional Programs.

Cronbach (1966) has pointed out the limitations of studies which compare two or more educational packages. It seems appropriate, in light of these criticisms, to consider the importance and advisability of using two instructional programs in the proposed research. In one sense, the proposed research does represent uniquely a direct comparison of the effectiveness of two instructional programs which purport to meet the same objective (i.e., to improve pupils' creative problem solving abilities). Thus, the legitimacy of comparison is increased since the criticism is that programs which have different objectives, even though they both bear a common gross title, should not be compared. But the proposed research goes beyond what Cronbach called "the comparison of gross effects" (1966, p. 543), in that it seeks further to identify explanatory principles, to identify conditions under which the instructional materials are more or less effective, and to specify the criteria which are influenced. In addition, it is possible to consider the value of utilizing more than one instructional program, in order to generalize more adequately about the influence of teacher participation and teacher's level of divergent thinking ability

on training in creative problem solving. Finally, the programs which will be utilized in the proposed research represent different approaches to the common goal of development of creative problem solving abilities. The PCTP attempts to develop these abilities utilizing content that relates directly to the social studies curriculum. In contrast, the PTP seeks to foster creative problem solving abilities in a broad, general context, assuming that the abilities and skills involved can be transferred to a wide-range of problem-solving situations.

Special Problems in Research on Creative Problem Solving.

In any investigation of creative problem solving in educational and psychological research, there are special problems involving the selection and use of criteria. What kinds of criterion measures can be used to assess creative problem solving? This appears to be particularly important in research which is addressed to the effects of training or instruction. First, there is a need to identify criteria which are valid, reliable, and relevant. Second, the criterion measures in training research must be sufficiently distinct from the training material so that they constitute an appropriate test of the effectiveness of the training, rather than an extension of the training *per se*. Third, they should be sensitive to change (Harris, 1963).

The Torrance Tests of Creative Thinking (Torrance, 1966) have been used, in their present form as well as in earlier versions, in many research programs in this area. Recently, however, their appropriateness has been questioned (Wallach and Kogan, 1965; Wallach, 1968; see also: Feldhusen, Treffinger, Van Mondfrans, and Ferris, 1971; Van Mondfrans, Feldhusen, Treffinger and Ferris, 1970). The position taken in the present research is that creativity is a complex human problem solving process (cf., Guilford, 1967) which necessarily involves divergent production abilities. The divergent thinking functions of fluency, flexibility, originality, and elaboration are viewed, therefore, as "first order components;" they are necessary, but not sufficient, aspects of the assessment of creativity. Since the Torrance Tests are the most frequently used instruments to assess these abilities among groups of elementary school children, it has been concluded that, for the purposes of this research, they are appropriate to use as one set of criteria for assessing the effectiveness of the creativity instructional materials.

Treffinger, Renzulli, and Feldhusen (1971) discussed the problem involved in assessing creative problem solving in general; these problems seem particularly critical in any attempt to assess the effectiveness of some training program or procedure. Treffinger, Feldhusen and Rezulli (1971) concluded that measures of divergent thinking may provide a useful and necessary, but *not* a sufficient component, of the assessment of creative potential. Treffinger (1970) proposed that a more comprehensive measure of creative problem solving would be correlated with divergent thinking, but would also be significantly related to other cognitive abilities.

In discussing the limitations of convential test procedures, Covington (in press) argued that because of the distinctive nature of the creative process, there are special problems and difficulties associated with its measurement. One fifficulty lies in the fact that conventially used tests are not well suited for appraising creative thinking. Creative thinking implies deep personal involvement to a problem, yet convential test procedures often rely on artificial and highly contrived situations which do not interest the student. These tests are highly formalized and simplified, having little resemblance to problems creative individuals would choose to work on. The problems appear to be "silly" or "stupid" to the students.

Also, present tests require the student to work on a number of short items within rigid time limits (e.g., TTCT, Product Improvement, 8 minutes; Just Suppose, 5 minutes; Picture Completion, 8 minutes.) But creative thinking is commonly typified by periods of intense application and periods of inactivity. To place premiums on speed and fluency seems to miss the point of creativity (Wallach, 1968; Covington, in press.)

Many of the current tests appear artifically to divide the construct of creativity into separate components, such as fluency, flexibility, and originality, much in the manner of a multifactor approach to intelligence testing (Guilford, 1967; Mednick, 1962). This seems to be particularly true when the intent is to develop "factorially-pure" tests which reflect the essence of a specific cognitive function, relatively independent of other cognitive domains. Such tests are typically highly formalized, simplified, and arbitrary; they exhibit little resemblance, therefore, to the kinds of tasks which a creative person might actually choose to work on.

Although, in general, these laboratory-oriented approaches are of demonstrated value in contributing to the understanding of various specific aspects of creative thinking, they overlook the fact that the creative process itself is characterized primarily by the coordination and management of these "cognitive part-functions." To measure these specific skills separately, and in isolation, without attempting to determine the degree of adeptness with which the individual deploys and sequences his particular complement of skills is to miss an essential element of the creative process.

Moreover, tests of creativity based on traditional mental test procedures are typically treated as indices of sheer capacity. To this end, all directions are clear and concise, all ambiguities concerning the correct performance set have been eliminated, and the student knows exactly what is required of him and exactly how much time he has to complete the work. Yet, the creative process is typified by a spontaneous disposition to use these skills and strategies without being expressly directed to do so. When working on a complex problem, the individual

cannot always depend upon well-ordered, unambiguous instructions from outside sources, but rather must rely primarily on his own intuition as to what course of action to pursue, which facts to heed,etc. Thus, in addition to testing sheer capacity, it is of crucial importance to measure the individual's particular pattern of propensities or dispositions which spontaneously arise within the content of a creative problem.

In summary, techniques are needed for the appraisal of creative thinking which reflect as fully as possible the rich complexities of creative thought, which allow for the distinctive dispositions and cognitive styles of the creative person, but which at the same time, permit a reasonable degree of standardization and the use of objective scoring procedures -- conditions which are necessary for any meaningful and reliable appraisal of behavior.

In addition to divergent thinking measures, therefore, other criteria are also necessary. These must include complex kinds of problem solving measures. Thus, in the present investigation, several different methods of assessing creative problem solving were employed. These measures, described in the Procedures section, included several developed at Purdue University, which were tested in a pilot project during the fall semester (1969-1970). They included problems which build on the recent work of Davis (1966), Miles (1968), Treffinger and Ripple (1968) and Covington (in press).

Objectives of the Research.

The following were the specific objectives of the research:

(1) To evaluate the effectiveness of the Productive Thinking Program and the Purdue Creativity Training Program under conditions of self-instructional use, compared with utilization which incorporates active teacher participation in the instruction.

(2) To compare the effectiveness of the PTP and the PCTP under two distributions of training: Massed (completing the lessons in 4 weeks) and Distributed (completing the lessons in 8 weeks).

(3) To compare the effectiveness of the two instructional programs, in each of the conditions specified in objectives one and two, in classes taught by teachers who are themselves high or low in divergent thinking ability.

(4) To assess the effectiveness of the programs, under the conditions specified in objectives one through three, with respect to several criteria of creative thinking and problem solving.

Appropriate hypotheses, tested in null form, were tested for each of these objectives.

CHAPTER TWO:

DESIGN OF THE STUDY AND METHOD

This chapter will provide information concerning the sample, procedures, instruments, and treatment of the data.

Sample

The sample consisted of 793 pupils and their teachers from 36 fifth-grade classes in two public school systems, one in northern Indiana and the other in southern Indiana.

Procedures

Five sub-tests from the Torrance Tests of Creative Thinking (Torrance, 1966) were administered to all teachers to determine their level of divergent thinking ability. A median split was then used to divide the teacher into a high group and a low group. Teachers in the high and those in the low group were separately assigned to treatment conditions on a random basis.

Pupils in classes assigned to the PTP and PCTP conditions studied 16 instructional units over a period of either four weeks (four units per week) or eight weeks (two units per week). Pupils in the four week groups began instruction after a delay of four weeks, so that instruction was completed in the same week in all experimental classes.

Teachers assigned to discussion treatments interacted with the pupils, discussing the materials and attempting to foster creative thinking and problem solving among the pupils.

Teachers assigned to non-discussion treatments distributed the materials and supervised the students, but had minimal interaction with the students about the content of the programs, and non-discussion of the lessons.

Classes assigned to the control group continued their normal classroom activities, with no special instructional treatment.

All pupils were given pre- and post-tests, described in the next section of this chapter. The final design of the study is summarized in Figure 1.

TEACHER LEVEL		PCTP		PTP		
		4-week	8-week	4-week	8-week	CONTROL
HIGH	DISCUSS	39*	41	43	49	
	NO DISCUSS	47	40	47	39	86**
LOW	DISCUSS.	36	40	50	47	
	NO DISCUSS.	48	53	46	39	

*The number indicates the number of students in each group; each group is comprised of 2 classes, except the Control, in which there were 4 classes.

**The control group was not stratified according to teacher divergent thinking or discussion.

Figure 1

Design of the Study

Instruments

The following instruments were administered to all pupils in the experimental and control classes:

(1) Divergent thinking. All pupils were given as a pre-test five sub-tests from Form B of the Torrance Tests of Creative Thinking, Research Edition (TTCT; Torrance, 1966); the five comparable sub-tests from Form A were given to all pupils as post-tests at the conclusion of instruction in the experimental groups. Three of the sub-tests utilized were from the verbal battery (Product Improvement, Unusual Uses, and Just Suppose) and two were from the figural battery (Picture Completion and Incomplete Figures). The tests were administered by trained members of the project staff, to classroom groups in their regular classrooms. Although all examiners followed carefully defined procedures, directions were written so as to minimize the appearance of formal "test" procedures. Eight minutes were allowed for each verbal task, and five for each figural task. Scoring was conducted by trained personnel at Purdue, following the guidelines provided by Torrance (1966), and inter-rater reliability was very high. For each pupil, six scores were derived for both pre- and post-tests; these were verbal and figural fluency, flexibility, and originality.

Although there has been some discussion of the validity of the TTCT (e.g., Wallach, 1968), evidence reviewed for the tests' validity and reliability by Torrance (1966), Wodkte (1963), Treffinger and Ripple (1968), Feldhusen, Treffinger, and Thomas (1971) and others has been considered sufficiently persuasive to warrant the use of these measures in the present study. Detailed review of these problems is beyond the scope of the present report, but is considered in detail by Treffinger, Ripple, and Ferris (in press). We concluded, for the present study, that the six dependent variables derived from the TTCT constituted an appropriate, although not sufficient, set of criteria.

Accordingly, three other major post-test criteria were employed: the Old Black House test, a programed problem solving task developed by Wardrop and his associates[1]; real life problems; and, selected other creative problem solving measures. Each of these will be described briefly.

(2) The Old Black House Test. The Old Black House Test yields four indices: Number of Ideas, Number of Discrepancies, Quality of Ideas, and Achievement of Solution. This test was presented to the students in the form of a brief written story. A copy of the test is included as Appendix A. The story begins as a detective drives out to the country to investigate

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[1]Permission to reproduce and use the Old Black House Test, extended by Dr. Martin Covington, is acknowledged with thanks.

an old black house in which gold is reported to be hidden. The detective finds the house in the late afternoon and begins his search, but he stops his search just before sunset and goes to a nearby white house to eat supper and spend the night. When he awakens the next morning the detective discovers that the black house has disappeared without leaving a trace of what happened. The problem is to explain how the black house could have disappeared. Embedded within the story are several discrepancies (e.g., the detective saw the sunset through his bedroom window but saw the sunrise through the same window when he awoke the next morning) which remain unaccounted for if one assumes that the black house must somehow have been torn down or moved. The problem can be solved in a way that accounts for the discrepancies --it was actually the detective who was moved, in his sleep, to a similar white house a short distance away from the black house. This is the principal solution --one which accounts for all the discrepancies and meets all the requirements of the problem.

The story, containing all the essentials of the problem, was presented to the students on the first page of a short booklet. On the next page, he is asked to write down all the ideas he has for explaining how the black house could have disappeared. He is encouraged to write as many ideas as possible, especially unusual ones. After writing his ideas, he turns the page and then is asked to write down any odd or puzzling facts he has noticed in the story (excluding the disappearance of the black house.) The following page provides feedback, focusing the student's attention on the several odd or puzzling facts in the story. Then he is given another opportunity to write down any new ideas he has for explaining how the black house could have disappeared. Next, a succession of question-response- feedback units gradually provides the student with more and more information about the problem, giving him additional opportunities to write down any new ideas he has for explaining how the black house could have disappeared and leading him step-by-step toward the principal solution. Finally, he is given a last opportunity to write down ideas for explaining the disappearance of the back house.

Scoring. For this posttest the following performance indicators were used: whether or not the student achieved the principal solution to the problem (i.e., the detective was moved to another similar white house) or half solution (i.e., the detective was moved, but not specifing that he was moved to a similar white house); the number of discrepancies in the problem which he noticed; the number of ideas he wrote for explaining the disappearance of the black house (regardless of the quality or adequacy of the ideas); and, the quality of the ideas he produced (as measured by a normative rating scale.)

The quality of an idea was judged on the basis of (1) the degree of imaginativeness exhibited and (2) the extent to which it accounted for the various facts without violating the constraints of the problem. In previous research with this problem (Wardrop et al., 1969), a normative scale of quality which incorporated these two criteria was prepared (see Figure 2). Each idea which the student produced in working on the problem was rated with respect to this scale. The writer also consulted with Dr. Robert Olton to insure that the scoring procedures employed in the Purdue Creativity Project were the same as those used in the previous research.

Each test was scored independently by two graders and then checked to determine any discrepancies. Interrater reliability for the scorers ranged from .95 to .99 for each of the four scores.

(3) Real-life problems. Both Covington (in press) and Miles (1968) have stressed the importance of identifying problem situations that are viewed by the examinee as "relevant" or "meaningful." Miles (1968) developed criteria for the construction of such problems, and for scoring for fluency and originality among college students. For the present study, two real life problems were presented to all pupils, as post-test measures. These problems, entitled "Fighting on the Playground," and "Life at School," were used in a pilot study during the 1969-70 year. Since work subsequently conducted using these variables has shown substantial correlations ($r \geq .90$) between the fluency and originality scores derived from the problems (Reichelt, 1971), they were scored only for fluency (i.e., number of solutions) for the present analyses. A copy of the problems, as used in the study, is included as part of Appendix B.

(4) Other problems. Although the amount of testing time available in the cooperating schools was necessarily limited, all pupils were also given two other problem solving tasks. The first was a multi-solution anagrams task, and the second was a word-generation task called "Antelopes." Copies of both tasks appear as part of Appendix B. Initial development and validation of these tasks was reported by Curtis (1970). Again, in view of extremely high correlations between fluency and originality scores, only fluency (i.e., number of solutions produced) was utilized in the present study.

Summary of variables. Thus, fourteen post-test criteria were employed. Six variables were derived from the TTCT, four from the Old Black House Problem, two from real-life problem tasks, and two from verbal problem solving measures. Separate analyses were conducted for each variable.

Rating	Type of Ideas	Examples
0	Ideas which are irrelevant, impossible, or contrary to fact	The black house was never there at all; a magician destroyed it
1	Ideas which explain the apparent disappearance of the black house, but which account neither for the fact that no trace of the house was found nor for the discrepancies in the story	The black house blew up; it was torn down
2	Ideas which account for both the apparent disappearance of the house and for the fact that no trace of the house was found, but still do not explain the discrepancies in the story	It was removed by a helicopter; it was moved by a truck and then the tracks were covered; it was carefully camouflaged during the night
3	Ideas which explain the apparent disappearance of the black house, and which account for all the facts and discrepancies in the story, but can only do so by denying the reality of the problem	The detective was drugged during supper, so he was confused when he woke up and only <u>thought</u> the black house had disappeared; the drugs made him see things strangely; it was all a dream
4	Elegant, feasible, ideas which account for all the facts and events	The principal solution: The <u>detective</u> was moved to another highly similar white house during the night

Figure 2

Normative Quality Ratings for Ideas

The Old Black House Problem

Active Teacher Participation

In the pre-experimental instructions to participating teachers, it was explained that each of the programs was originally developed as a self-instructional program, and some generalizations about the characteristics of programed instruction were provided. It was also indicated that each program had been successfully utilized with fifth-graders on a self-instructional basis in previous studies. The teachers were also told that they would receive directions concerning their utilization of the program.

In the non-discussion groups, teachers were given directions concerning only such administrative matters as distributing the material, schedules of lesson use, answering pupils' questions, and collection of the programs. Teachers were directed to make no other formal applications of the specific content of the programs.

In the discussion groups, however, teachers were given instructions which stressed the importance of active participation and application of the content of the instructional materials. They were given suggestions for bulletin boards, role playing, class discussion, and applications for specifc units in other curricular areas.

Each teacher with a discussion group assignment was asked to provide a summary list of activities conducted, for the purpose of verifying that the discussion condition actually varied from the non-discussion condition. Examination of the teachers' lists revealed that all discussion teachers did participate actively, and in several of the suggested projects.

Treatment of the Data

The data were analyzed using a four-way analysis of variance for unequal cells, with a single control group (Winer, 1962). The four factors were (a) instructional program (PTP or PCTP); (b) active teacher participation (yes or no); (c) teacher divergent thinking ability (high or low); and (d) distribution of training (four weeks or eight weeks). Dunnett's t statistic (Winer, 1962) was used to test cell and main effect means against control means, and the Newman-Keuls test (Winer, 1962) was also employed as a post-hoc test where appropriate. The .05 level of significance was accepted for all tests.

Since examination of the pre-test TTCT scores revealed significant differences among experimental tests, analyses were conducted using simple gain scores (differences between pre- and post-test scores plus a constant of 50 to remove negative scores). For all problem solving criteria, analysis of variance on post-test scores was employed.

The Model for Analyses.

It should be noted that the particular focus of the study was to identify combinations of effects in the four-way ANOVA model which differed significantly from each other and from the uninstructed or "control" condition.

That is, there did not appear to be any psychological or educational meaning to be drawn from a mean which differs significantly from other means in the four-way analysis of experimental means, but not from the control mean. It does not appear reasonable to conclude that a treatment combination which is not superior to control, which received no instructional treatment, might also be superior to some other instructional arrangement.

Further, if some arrangements do differ significantly from control, but not from other experimental arrangements, there is very little interest in them for the purposes of this study. That the instructional programs are, under some conditions, superior to no instruction, has already been established in previous studies.

Therefore, our strategy in conducting the analyses for the present project has been:

(1) To conduct an overall F-test (control versus all others).
If that test reveals significant differences, we proceeded to steps 2 and 3.

(2) Conduct the 4-way ANOVA and the Dunnett's T-tests for all significant main effects and interactions.

(3) Conduct Newman-Keuls tests when Dunnett's test has revealed significant experimental-control differences.

Thus, post-hoc tests of significant results from the four-way ANOVA were conducted, to clarify patterns of interactions, for example, only when the means involved had also been shown to differ significantly from the control group's mean.

CHAPTER THREE:

RESULTS OF THE STUDY

In this chapter, the results of the analyses described in Chapter Two will be presented. The first section will present the results for gain scores for the six TTCT variables. The second section will present the results for the four variables derived from the Old Black House Problem. The final section will present the results for the four variables derived from the Problem Solving Number One test.

Divergent Thinking Gain Scores

The TTCT yielded six scores, each of which constituted a separate variable for analysis. These were: verbal fluency, flexibility, and originality, and non-verbal fluency, flexibility, and originality. Table 1 summarizes the gain scores for all experimental and control groups on each of these six divergent thinking variables. Since a constant of 50 was added to each score, means greater than 50 indicate gains from pretest to posttest. It will be seen, from Table 1, that many experimental groups showed substantial gains, although there were also consistent, but somewhat smaller gains, in the control groups.

Table 1:

Mean TTCT Gain Scores

(Posttest Minus Pretest, Plus Fifty)

	Variable*	Four-week Low Teachers	Four-week High Teachers	Eight-week Low Teachers	Eight-week High Teachers
	1	53.33	53.22	51.83	57.30
PCTP,	2	50.00	50.98	50.69	52.52
NON-	3	70.82	64.51	63.90	71.48
DIS-	4	53.69	53.64	54.35	57.64
CUSSION	5	52.82	53.84	53.56	56.75
	6	57.54	57.31	61.33	67.32
	1	59.26	50.09	52.69	59.08
PCTP,	2	53.68	50.16	50.79	52.65
DIS-	3	69.84	63.74	59.77	75.22
CUSSION	4	55.55	52.37	54.05	55.98
	5	55.21	53.16	53.23	55.48
	6	61.18	56.72	57.23	57.85
	1	59.77	60.53	58.28	60.42
PTP,	2	53.30	53.29	52.94	54.31
NON-	3	68.33	74.84	62.15	68.17
DIS-	4	54.81	56.04	54.79	55.42
CUSSION	5	54.51	54.92	55.32	55.06
	6	61.86	65.06	62.30	64.67
	1	61.31	60.16	61.33	62.72
PTP,	2	55.54	52.65	53.09	55.28
DIS-	3	71.77	71.49	73.57	70.77
CUSSION	4	55.04	56.40	56.11	55.47
	5	53.83	55.21	55.15	55.23
	6	60.25	63.26	61.26	61.72

CONTROL
1) 53.84
2) 51.33
3) 62.83
4) 53.56
5) 54.00
6) 61.10

* Variables: 1-3 = Verbal (Fluency = 1, Flexibility = 2, Originality = 3)
4-6 = Nonverbal (Fluency = 4, Flexibility = 5, Originality = 6).

Tables 2-5 summarize the analyses for TTCT gain scores, for the four-way ANOVAS. Results of appropriate Newman-Keuls comparisons and Dunnett's t-test comparisons of experimental and control means are also summarized for each variable.

Verbal Fluency

Table 2 summarizes the analyses of verbal fluency gain scores. The over-all F-ratio, for control versus all other groups, was significant ($F = 8.38$, $p < .01$ with 1 and 777 df). The four-way ANOVA yielded significant results for: Program, the Time-Teacher Level Interaction, and the Program-Time-Teacher Level Interaction.

Further analyses indicated:

(1) The mean for the PTP group (60.56) were significantly greater than the mean for the PCTP group (54.72) and the control mean (53.84). The PCTP mean did not differ significantly from the control mean.

(2) For the Time-Teacher Level Interaction, only the four-week, Low Group (58.65) and the eight-week, High Group (59.88) were significantly greater than Controls (53.84). The Newman-Keuls test for this interaction, however, revealed no significant differences among the experimental group means.

(3) For the ACD interaction, the following groups were significantly greater than control: PCTP, Eight-week, High Teachers (58.19); PTP, four-week and eight-week groups, with both high and low teachers (60.35, 61.57, 60.54, and 59.80, respectively). The means for five experimental groups were also significantly greater than the means for the PCTP four-week, High Teacher Group and the PCTP, eight-week, Low Teacher Groups. No other Newman-Keuls test results were significant.

Table 2:

Analysis of Variance for Verbal Fluency Gain Scores

Source	MS	DF	F	P
Control vs. all others	1147.25	1	8.38	$<.01$
A (Program)	5941.76	1	43.42	$<.01$
B (Discussion)	330.91	1	2.42	n.s.
C (Time)	68.42	1	<1	n.s.
D (Teacher Level)	62.05	1	<1	n.s.
AB	11.12	1	<1	n.s.
AC	25.86	1	<1	n.s.
AD	6.25	1	<1	n.s.
BC	66.45	1	<1	n.s.
BD	264.28	1	1.93	n.s.
CD	1833.03	1	13.40	$<.01$
ABC	31.52	1	<1	n.s.
ABD	56.19	1	<1	n.s.
ACD	893.35	1	6.53	$<.05$
BCD	283.41	1	2.07	n.s.
ABCD	168.64	1	1.23	n.s.
Error	136.85	777		

Verbal Flexibility

Table 3 summarizes the results for gains in verbal flexibility. The overall F-test, for control versus all other cells, was significant ($F = 4.63$, $p < .05$ with 1 and 777 df). The four-way ANOVA yielded a significant main effect for Program, and significant Time-Teacher Level, and Discussion-Time-Teacher Level Interactions.

Further analyses yielded the following results:

(1) PTP groups' mean gain scores (53.80) were significantly greater than PCTP Groups' mean gain (51.50) and Control (51.33), while the PCTP and control groups did not differ fromeach other.

(2) Mean gains for the four-week, Low Teacher Groups (53.27) and the eight-week, High Teacher Groups (53.69) were significantly greater than Control (51.33). Newman-Keuls tests revealed no significant differences among the means of the experimental groups for the Time-Teacher Level Interaction.

(3) Mean gains for the Disucssion-Time-Teacher Level interaction did not differ significantly among the experimental arrangements (Newman-Keuls tests), although three groups (Non-Discussion-eight-week-High; Discussion-four-week-Low; and Discussion eight-week-High) were significantly greater than controls.

Table 3:

Analysis of Variance for Verbal Flexibility Gain Scores

Source	MS	df	F	P
Control vs. all others	135.65	1	4.63	<.05
A (Program)	915.27	1	31.22	<.01
B (Discussion)	75.77	1	2.59	n.s.
C (Time)	12.05	1	<1	n.s.
D (Teacher Level)	4.24	1	<1	n.s.
AB	0.08	1	<1	n.s.
AC	0.56	1	<1	n.s.
AD	0.09	1	<1	n.s.
BC	17.86	1	<1	n.s.
BD	97.10	1	3.31	<.10
CD	477.07	1	16.27	<.01
ABC	6.98	1	<1	n.s.
ABD	9.57	1	<1	n.s.
ACD	0.27	1	<1	n.s.
BCD	159.55	1	5.44	<.05
ABCD	0.20	1	<1	n.s.
ERROR	29.31	777		

Verbal Originality

Table 4 summarizes the analyses for verbal originality gain scores. The overall F-test was significant ($F = 9.34$, $p < .01$ with 1 and 777 df). The four-way ANOVA yielded significant F-ratios for Program; Time-Teacher; Program-Discussion-Teacher Level; and Program-Time-Teacher Level.

Further analyses yielded these results;

(1) Both PTP groups (70.13) and PCTP groups (67.38) differed significantly from controls (62.83), as well as from each other.

(2) The four-week groups, with either high or low divergent thinking levels for teachers (68.65 and 70.13, respectively), and the eight-week, high teacher group (71.41) were significantly greater than the control mean (62.83). The Newman-Keuls test, however, did not reveal any significant differences among the experimental group means.

(3) For the Program-Discussion-Teacher Level Interaction, although four groups (PCTP, discussion, high; PTP, non-discussion, high; PTP discussion high and low) differed significantly from control (69.48, 72.67. 71.50, and 71.13, respectively, versus 62.83), the Newman-Keuls test revealed no significant differences among the experimental groups' means.

(4) For the Program-Time-Teacher Level interaction, the PCTP, eight-week, high teacher group (73.35) and the PTP, eight-week, low teacher group (73.16) differed significantly from the control group (62.83) and, as determined by the Newman-Keuls test, from all other experimental groups except each other. Although two other groups differed significantly from Control (PCTP, 4, Low = 70.21 and PTP, 4, Low = 70.05), the Newman-Keuls test revealed no other significant differences among experimental groups.

Table 4:

Analysis of Variance for Verbal Originality Gain Scores

Source	MS	df	F	P
Control vs. all others	2893.10	1	9.34	$<.01$
A	1318.50	1	4.26	$<.05$
B	406.81	1	1.31	n.s.
C	275.66	1	<1	n.s.
D	1122.23	1	3.62	$<.10$
AB	694.31	1	2.24	n.s.
AC	492.90	1	1.59	n.s.
AD	5.56	1	<1	n.s.
BC	614.13	1	1.98	n.s.
BD	164.07	1	<1	n.s.
CD	2813.60	1	9.09	$<.01$
ABC	445.16	1	1.44	n.s.
ABD	1492.94	1	4.82	$<.05$
ACD	3963.98	1	12.80	$<.01$
BCD	94.22	1	<1	n.s.
ABCD	268.00	1	<1	n.s.
ERROR	309.68	777		

Non-verbal Fluency

Table 5 summarizes the analyses for non-verbal fluency. The overall F-ratio was significant ($F = 5.63$, $p < .05$ with 1 and 777 df). Further analyses revealed that the main effects for Program and for Time were marginally significant ($p < .10$). The significant interactions were: Program-Time; Program-Time-Teacher Level.

Further analyses indicated that:

(1) PTP group mean gains were significantly greater than control, both the four-week groups and the eight-week groups (55.50 and 55.44, respectively, versus 53.56 for Control). For PCTP, only the eight-week groups differed significantly from control (55.57 versus 53.56 for Control). Newman-Keuls tests did not reveal significant differences among any of the experimental group means, however.

(2) For the Program-Time-Teacher Level interaction, the PCTP-eight-week-High group (56.81) was significantly greater than control (53.56) and than all other experimental groups. The PTP-eight-week-Low group (56.22) was also significantly greater than control.

Table 5:

Analysis of Variance for Non-Verbal Fluency Gain Scores

Source	MS	df	F	P
Control vs. all others	190.34	1	5.63	$<.05$
A	120.72	1	3.57	$<.10$
B	0.56	1	<1	n.s.
C	101.63	1	3.01	$<.10$
D	53.06	1	1.57	n.s.
AB	32.37	1	<1	n.s.
AC	138.66	1	4.10	$<.05$
AD	1.38	1	<1	n.s.
BC	7.31	1	<1	n.s.
BD	82.55	1	2.44	n.s.
CD	96.59	1	2.86	n.s.
ABC	28.09	1	<1	n.s.
ABD	28.18	1	<1	n.s.
ACD	337.83	1	9.99	$<.01$
BCD	0.17	1	<1	n.s.
ABCD	25.27	1	<1	n.s.
ERROR	33.81	777		

Non-verbal flexibility

For non-verbal flexibility, the overall F-ratio for control versus all others, did not reach significance ($F = 1.25$, $p > .05$, with 1 and 777 df). Accordingly, no further analyses were conducted.

Non-verbal originality

For non-verbal originality, the over-all F-ratio for control versus all others was not significant ($F < 1$). Therefore, no additional analyses were conducted.

The Old Black House Problem

The Old Black House problem yielded four scores, each of which was separately analyzed and will be reported in this section. These variables were: number of ideas, number of discrepancies, attainment of solution, and rated quality of ideas.

Number of Ideas

For number of ideas, the over-all comparison of control versus all others was significant ($F = 7.057$, $p < .01$ with 1 and 777 df). Table 6 summarizes the results of the analysis of variance for this variable, in which a significant Program-Time interaction was found.

Further analysis of the data revealed that:

(1) Means for Instructed groups were greater than means for Controls; particularly for the PCTP, eight-week, Discussion, High Teacher Group (3.83 vs. 3.33 for Controls).

(2) Although several groups' means were reported to be significantly greater than controls, the Newman-Keuls tests revealed only that, for the AC interaction, the mean for the PCTP, eight-week group (4.52) was significantly

greater than the means for the PCTP, four-week group (3.76) and the PTP, eight-week group (3.81). The mean for the PTP, four-week group (4.37) did not differ from any of the other three experimental group means.

Table 6:

Analysis of Variance for Number of Ideas (Old Black House)

Source	MS	df	F	P
Control vs. All Others	51.101	1	7.057	<.01
A (Program)	0.473	1	<1	n.s.
B (Discussion)	7.405	1	1.023	n.s.
C (Time)	1.744	1	<1	n.s.
D (Teacher's Level)	3.506	1	<1	n.s.
AB	20.481	1	2.828	n.s.
AC	76.337	1	10.542	<.01
AD	11.200	1	1.547	n.s.
BC	3.214	1	<1	n.s.
BD	6.600	1	<1	n.s.
CD	19.914	1	2.750	n.s.
ABC	18.860	1	2.604	n.s.
ABD	7.769	1	1.073	n.s.
ACD	7.554	1	1.043	n.s.
BCD	5.870	1	<1	n.s.
ABCD	17.724	1	2.448	n.s.
ERROR	7.241	777		

Number of Discrepancies

For variable two, number of discrepancies, the overall F-ratio, for the comparison of control with all other groups, was not significant ($F = 3.781$, $p > .05$ with 1 and 777 df). Accordingly, further analyses were not conducted.

Attainment of Solution

For variable three, attainment of solution, the overall F-ratio was significant ($F = 22.196$, $p < .01$ with 1 and 777 df). Significant results in the four-way ANOVA included: Program, Time, the Time-Teacher's Level interaction (CD), and the Program-Discussion-Teacher's Level interaction (ABC). The results of the ANOVA are summarized in Table 7.

Further analyses indicated:

(1) The mean for the PTP groups (1.066) was significantly greater than the mean for PCTP groups (0.768); both were greater than the Control Mean (0.419);

(2) The mean for four-week groups (1.081) was significantly greater than the mean for eight-week groups (0.753), and both were significantly greater than the control mean (0.419).

(3) For the significant CD and ABC interactions, the Newman-Keuls tests revealed that the means for the four week groups with low teachers (1.164) and with high teachers (.998) were significantly greater than the mean of the eight-week groups with low teachers (.645). The four-week, low teacher group mean was also significantly greater than the mean for the eight-week, high teacher groups.

(4) The Dunnett's t-test comparison revealed that the following groups' means were significantly greater than the control mean: PCTP, 4 weeks, low teachers, discussion and non-discussion (1.00 and 1.06 vs. 0.419 for control); all 4 week PTP groups (1.186, 1.152, 1.400, and 1.192); and eight-week, PTP groups with high teachers, both discussion and non-discussion (0.857 and 1.179).

Table 7:

Analysis of Variance for Attainment of Solution, Old Black House Problem

Source	MS	df	F	P
Control vs. all others	20.331	1	22.196	<.01
A	15.548	1	16.973	<.01
B	0.028	1	<1	n.s.
C	18.809	1	20.533	<.01
D	0.107	1	<1	n.s.
AB	1.888	1	2.061	n.s.
AC	0.004	1	<1	n.s.
AD	0.166	1	<1	n.s.
BC	0.303	1	<1	n.s.
BD	1.262	1	1.378	n.s.
CD	6.307	1	6.885	<.01
ABC	5.095	1	5.562	<.05
ABD	0.178	1	<1	n.s.
ACD	0.011	1	<1	n.s.
BCD	0.769	1	<1	n.s.
ABCD	1.769	1	1.931	n.s.
ERROR	0.916	777		

Quality of Ideas

The F-ratio for the overall comparison of control versus all other groups for variable four, quality of ideas, was significant ($F = 11.303$, $p < .01$ with 1 and 777 df). The ANOVA for this variable, which is summarized in Table 8, yielded the following significant main effects and interactions: Program, Time, Program-Time, Discussion-Teacher's Level, Program-Discussion-Time, and Discussion-Time-Teacher's Level.

Further analyses indicated:

(1) The mean for the PTP group (136.25) was significantly greater than the mean for the PCTP group (109.44), and both were significantly greater than the control mean (80.87).

(2) The mean for four-week groups (137.11) was significantly greater than the mean for the eight-week groups (108.59), and both were significantly greater than the control mean (80.87).

(3) The means in the discussion-teacher level interaction did not differ significantly in the Newman-Keuls comparisons.

(4) For the program-time interaction, the Newman-Keuls test indicated that the means for the PTP-four-week, PTP-eight-week, and PCTP-four-week groups were significantly greater than the mean for the PCTP-eight-week group.

(5) The means for the interaction of program, time, and discussion were further examined, using Newman-Keuls comparisons. These indicated that the means for PCTP and PTP, four-week, discussion and non-discussion, plus the PTP non-discussion eight-week mean, were significantly greater than the mean for PCTP, non-discussion, eight-weeks.

(6) For the means in the discussion-time-and teacher level interaction, Newman-Keuls tests indicated that for low teachers in four-week groups, with or without discussion, and high teachers in four-week groups with discussion, means were significantly greater than for eight-week groups without discussion, taught by low teachers.

(7) Dunnett's comparisons revealed that the following groups' means were significantly greater than the control means: PCTP, four-week, low teachers, discussion and no-discussion; all PTP four-week groups, and, when PTP was used in eight-week groups, for High teachers without discussion and low teachers with discussion.

Other Problem Solving Criteria

Four other problem solving criteria were included in the present analyses; these were derived from the test, "Problem Solving Number One," described in Chapter Two. These criteria were: (1) a multi-solution anagrams task; (2) a word-fluency problem (making up words contained in the letters of a given stimulus word); (3) a "real-life" problem concerning fighting on the playground; and (4) a problem concerning the improvement of school. For each problem, the dependent variable was number of solutions obtained.

Multi-solution anagrams

For the multi-solution anagrams task, the over-all F-ration was significant ($F = 4.658$, $p < .05$ with 1 and 737 df).* The four-way ANOVA, which is summarized in Table 9, yielded significant results for: Time, Teacher's level, the Time-Teacher's level interaction, the Program-Discussion-

*The total N for these analyses was 753, since fewer subjects completed this post-test becuase of absence from school on the day it was administered. This loss did not appear to be disproportionately distributed among any of the experimental or control groups.

Time Interaction, the Program-Time-Teacher's level interaction, and the four-way interaction.

Table 8:

Analysis of Variance for Quality of Solutions, Old Black House Problem

Source	MS	df	F	P
Control vs. all others	144320.123	1	11.303	$<.01$
A	125592.617	1	9.836	$<.01$
B	7965.421	1	<1	n.s.
C	142118.031	1	11.130	$<.01$
D	2099.761	1	<1	n.s.
AB	32026.332	1	2.508	n.s.
AC	56944.837	1	4.459	$<.05$
AD	14529.760	1	1.138	n.s.
BC	1907.691	1	<1	n.s.
BD	62747.011	1	4.914	$<.05$
CD	28520.860	1	2.234	n.s.
ABC	84952.612	1	6.653	$<.01$
ABD	9525.424	1	<1	n.s.
ACD	4931.987	1	<1	n.s.
BCD	56838.634	1	4.451	$<.05$
ABCD	8194.149	1	<1	n.s.
ERROR	12768.539	777		

Further analyses indicated:

(1) For the complex four-way interaction, no pattern of differences among the means could be discerned. In addition, when each of the 16 cells was compared with the control mean, only three were significantly greater (PCTP, non-discussion, four-week, low; PTP, discussion, four-week, low; and PTP, discussion, eight-week, high).

(2) For the program-discussion-time interaction, only the PCTP-non-discussion-four-week group (4.51) and the PTP-discussion-four-week group (4.70) were significantly greater than controls (3.53).

(3) For the program-time-teacher level interaction, the PCTP, four-week group with high teacher (4.41) was significantly greater than control (3.53), as were only two other groups: PTP, four-week, low teacher (4.82) and PTP, eight-week, high teacher (4.53).

(4) For the time-teacher level interaction, only the mean for the four-week groups with low teachers (4.35) was significantly greater than the Control mean (3.53). The experimental means, examined by Newman-Keuls procedures, did not differ significantly.

(5) High teachers (4.23) differed significantly from the Control mean, and from all low teachers (3.90), and four-week groups (4.28) differed significantly from eight-week groups (3.85) and from controls (3.53).

Table 9:

Analysis of Variance for Multi-Solution Anagrams

Source	MS	df	F	P
Control vs. all others	21.935	1	4.658	$<.05$
A	1.085	1	<1	n.s.
B	0.197	1	<1	n.s.
C	31.427	1	6.674	$<.01$
D	18.828	1	3.998	$<.05$
AB	11.519	1	2.446	n.s.
AC	5.642	1	1.198	n.s.
AD	0.003	1	<1	n.s.
BC	1.977	1	<1	n.s.
BD	0.066	1	<1	n.s.
CD	37.968	1	8.063	$<.01$
ABC	23.307	1	4.949	$<.05$
ABD	17.168	1	3.646	n.s.
ACD	72.730	1	15.445	$<.01$
BCD	3.295	1	<1	n.s.
ABCD	56.679	1	12.036	$<.01$
ERROR	4.709	737		

Word Fluency Problem

For variable two, making up words, the over-all F-ratio was not significant ($F = 2.16$, $p > .05$, with 1 and 737 df). Therefore, further analyses were not conducted.

"Real-life" problems

For variables three (fighting on the playground) and four (life at school), neither over-all F-ratio was significant ($F < 1$ and $F = 1.115$, respectively). Therefore, further analyses were not conducted.

Chapter Summary

The results of the study were presented in three major sections: (a) TTCT gain scores; (b) scores from the Old Black House Problem, and (c) scores from the Problem Solving Number One test.

For each variable,an over-all F-ratio was computed in which the control mean was compared with all other means. If this was significant, further tests were conducted: a four-way ANOVA among experimental group means, with post-hoc Newman-Keuls tests where appropriate, and comparisons of group and cell means with control means as appropriate, employing Dunnett's t-test. In the absence of a significant over-all F-ratio, no further statistical tests were conducted.

CHAPTER FOUR:

DISCUSSION, SUMMARY, AND CONCLUSIONS

In this chapter, the results of the study will be examined in relation to the specific hypotheses of the study, and interpreted in relation to the theoretical rationale described in Chapter One. The study will be summarized, and conclusions and implications for future research will be drawn. The discussion of the results will follow the order in which the results were presented in Chapter Three: TTCT, the Old Black House, and Problem Solving Number One. Within these sections, the major concerns of the study (comparisons of programs, time, teacher involvement, and teacher's level of divergent thinking) will be examined.

Divergent Thinking Measures

In general, the results of the study warrant the conclusion that divergent thinking abilities, as measured by the TTCT, can be significantly enhanced through instruction with these programs. This conclusion is particularly true for the verbal aspects of divergent thinking, and for nonverbal fluency. There did not appear to be any significant enhancement of nonverbal flexibility or originality.

Although no comparisons of the two programs were consistent across all instructional arrangements, or for all divergent thinking criteria, some differences did appear. For verbal fluency and verbal flexibility, mean gains of pupils in PTP groups were greater than the mean gains of Control pupils, while this was not true for pupils in all PCTP groups. For each divergent thinking variable, there were several instructional arrangements in which an experimental arrangement appeared to lead to greater gain scores than no instruction.

The following generalizations about specific instructional arrangements appear to be supported by the data, with respect to verbal divergent thinking abilities and non-verbal fluency:

(1) Among teachers high on divergent thinking, instruction tended to be effective with the Productive Thinking Program, with or without discussion, and more effective over an eight-week period than a four-week period. For the teachers in this group using PCTP, best results were obtained with discussion and an eight-week period.

(2) The four-week presentation was most often effective when used by low teachers (compared with control groups).

(3) The PTP seemed less influenced by variations in time, discussion, and teacher level than did the PCTP.

These general findings seem to confirm some of the original intentions of the developers of the programs. The Productive Thinking Program was intended originally to be a self-instructional program. The Purdue Creativity Training Program, however, was initially developed with teacher participation, and was used at a slower rate and over a longer period of time. Its effects, not surprisingly, may not be as apparent under a more intense rate of presentation.

It should be noted also that, although the original 28-tape PCTP series included many activities which were non-verbal in nature, the 16 programs utilized in the present study were of a more verbal nature. The PTP, moreover, is highly verbal in its content. As a result, the lack of significant effects on the non-verbal divergent-thinking criteria is not surprising.

Although the PTP was effective in developing some divergent thinking variables (e.g., verbal fluency and verbal originality) with both high and low teachers, the conditions under which it was most effective with each group of teachers are not clear. For these variables, the PCTP appeared more effective with low teachers in four weeks and, when used over an eight-week period, with high teachers. Perhaps the self-instructional, "programed" format of the PTP is more "resistant" to external influence, whereas, as time increases, the teacher's divergent thinking becomes more important in groups using the PCTP. This should be clarified in a more detailed follow-up study.

Indeed, one of the great difficulties of the present study has to do with the validity of the use of divergent thinking measures to classify the teachers. It is possible that an entirely different basis of classification would be more effective in examining the effects of various instructional efforts. This problem will be considered in greater detail in the final section of this chapter.

The Old Black House Problem

This problem was originally developed to attempt to solve some of the problems associated with the assessment of creative problem solving (Covington, in press; Brunner, 1971). As such, it seemed appropriate to include as a part of the criterion battery in a "training" study, such as the present one. However, since the problem was originally developed for use with the Productive Thinking Program, by the senior author of that program, it might be thought to be a measure more sensitive to the effects of that program than the PCTP, which is quite different in

format and presentation. It was found, however, that PCTP groups did, in several cases, perform significantly better than control pupils.

The PCTP groups were superior to controls on number of ideas, attainment of solution, and quality of ideas. This provides evidence that instruction with the PCTP can enhance more complex creative problem solving abilities among fifth-grade pupils.

The PTP groups were also superior to controls on each of these three variables, and, for attainment of solution and quality of ideas, the PTP groups were also superior to the PCTP groups. Although the latter comparison was not surprising, in view of the similarities of format and presentation, it appears that the PTP can also be utilized effectively to develop creative problem solving abilities among fifth-grade pupils.

The lack of significant results for the identification of discrepancies in this problem may be accounted for by the fact that this is a very difficult criterion,upon which very few pupils attained any positive score, and by the fact that PCTP provides only very indirect training in related skills. The PTP provides some practice in the recognition of "puzzling" facts in a problem, but there is no evidence that this constitutes a major component of the program's content.

The effects of time,discussion, and teacher's level of divergent thinking were again less clear-cut. For number of ideas, which is obviously quite similar to the verbal fluency measures in the previous section, the PCTP appeared to be most effective in the eight-week presentation, and, within that arrangement, when used in conjunction with discussion by high teachers. The PTP groups, in four-weeks, were superior to controls,

with or without discussion, and with high and low teachers. Thus, as for divergent thinking, it appears that the PCTP is better employed with high teachers at a slower rate, and that teacher involvement with this program is valuable.

For the attainment of solution variable, both four- and eight-week groups were superior to control, but the least effective arrangement appeared to be eight-weeks with low teachers. Four-week groups were superior to controls, whether teachers were high or low. All four-week PTP groups, and the eight-week PTP groups with high teachers, were superior to controls, regardless of discussion. For the PCTP, four-weeks, groups taught by low teachers were superior to controls.

For the quality of ideas variable, again, four-week groups were, in general, superior to eight-week groups, but both were superior to controls. It was also true that,for four-week groups, low teachers' groups scored higher than for similar classes in the eight-week presentation and for controls. For the PCTP, the eight-week groups, especially if without discussion and taught by low teachers, tended to be lower than four-week groups with and without discussion. When the PTP was used in eight-weeks, however, mean scores were still significantly greater than controls, particularly for high teachers --no discussion, and low teachers with-discussion!

Problem Solving Number One

The results for the Problem Solving Number One test were very disappointing; only for one variable, multi-solution anagrams, were there any significant results.

Perhaps the problems presented in this test involved a format so much different, or so much more general, than that of the training provided in any of the instructional arrangements, that the pupils' performance was not significantly influenced. It is clear that the rather formal, test-like nature of these four tasks is quite unlike any of the activities in the instructional programs. Thus, these tasks constituted a very difficult, and perhaps too severe, criterion of transfer from the instructional programs.

For the multi-solution anagram task, the results were very complex, and no pattern of differences in relation to the hypotheses could readily be discerned. For the PCTP groups, however, mean scores were significantly greater than control means for the non-discussion, four-week, low teacher groups, whereas, for PTP groups, the means were significantly greater than controls for both rates of presentation, and at each level of teacher divergent thinking ability.

General Summary of Results

The results of this study, in their most general form, appear to be summarized in the following statements:

(1) Both the PCTP and the PTP have been shown to effect significant enhancement of fifth-grade children's divergent thinking abilities (particularly verbal abilities).

(2) Both programs have been shown to be associated with superior performance by fifth-grade pupils, in comparison with control pupils, on several criteria of creative problem solving.

(3) The PTP, originally designed as a self-instructional program, appeared to be less influenced by variations in rate of presentation, teacher participation, and teacher's level of divergent thinking, than had been anticipated. There was some evidence, however, that as rate of presentation of the PCTP decreases (i.e., as the instructional period is lengthened), the role of discussion and the positive effects of high divergent thinking ability in the teacher will increase.

(4) When the programs are utilized in as short a period of time as four weeks, superior performance seemed to be associated with more frequently with non-discussion, and with teachers low in divergent thinking ability.

The Results In Context

These results provided further evidence that some creative thinking and problem solving abilities of fifth-grade pupils can be positively influenced by deliberate instructional efforts. The results concerning the influence of distribution of the training, active teacher involvement, and the influence of the teacher's level of divergent thinking ability were much less clear than might have been expected; it seems appropriate, therefore, to inquire how these findings may contribute to our understanding of creativity training research in a more general and theoretical context. There are several things which have become very clear during the course of this research, and which merit consideration here.

Difficulties of Defining Treatments

The first problem is one very commonly encountered in educational research, especially when undertaken in classroom settings. It is very difficult to define with accuracy the specific "treatments" in the study and to verify the extent to which they actually occurred. Consider two examples: the Programs themselves, and the teacher involvement variable. To what extent can we be assured that pupils actually participated actively in working with the instructional program assigned to their group? To what extent did some pupils, by virture of lack of interest, time, or ability, actually learn less of the specific content of the program than others? Nonetheless, in the absence of any criterion measures designed specifically to assess whether the pupil actually received the instruction, we can only hazard the guess that most pupils do attempt to do the work with which they are provided in school; randomization should, in general, protect the study from seriously biased distributions of pupils who were unable to learn from the instruction.

For the teacher involvement variable, it is difficult to know, without extensive classroom observation (which might itself bias the results), that teachers in discussion groups were active,and as a group, that their activity was significantly different from the activity of teachers in the non-discussion groups. Although discussion group teachers provided records to demonstrate that activities had been undertaken,

there is no evidence concerning the quality of those activities. Nor can there be any assurance that some non-discussion teachers unknowingly and unintentionally engaged in behavior with their pupils, at various times during the school day, which constituted "participation" to the same or greater extent than that conducted by discussion group teachers. Thus, a defined treatment, the levels of which can be externally distinguished and verified, was not really possible within the limitations of this project.

Validity of Teacher Divergent Thinking Scores

The use of TTCT test scores for assessing the divergent thinking abilities of teachers as an independent variable in this study also involved some problems. First of all, there are no well-validated norms for elementary school teachers for these tests, to our knowledge. Thus, it is really not possible to refer to our groups as "high" or "low" divergent thinkers in any absolute sense of the classification. Since a median split was used, our high-low groups should be interpreted only as higher or lower in the framework of our sample. Whether either group would be high or low scoring, in comparison with the teacher population, cannot be determined.

In addition, a very difficult question, which is also of theoretical interest, also presents itself. In developing this project, it was assumed, as is very common to do, that teachers who score high on measures of creative thinking are needed to facilitate creative development in their pupils. Thus, despite even the original self-instructional nature of the PTP, it might be reasonable to expect that a high-scoring teacher would enhance the effects of instruction.

It has become very clear,however, that the relationship between teacher's abilities and pupils' abilities is much more complex, and so it may be necessary to call into question our original, simple expectation.

It may be that there is a considerable difference between a person who scores high on measures of divergent thinking and happens also to be a fifth-grade teacher, on the one hand, and a teacher who fosters creative abilities among fifth-grade pupils, on the other. Thus, it may be that even if divergent thinking scores do distinguish more divergent from less divergent teachers, they may not distinguish those who foster creativity in children from those who do not.

Complexity of the Construct of Creativity

Finally, it is necessary to recognize that, in all of the instructional arrangements in this study, the total amount of instruction provided constitutes only a very small part of the pupils' school experience, and that creative thinking and problem solving abilities represent very complex aspects of human behavior. In fact, in view of the brevity of the instructional intervention and the complexity of creativity, it is rather impressive to identify significant results on several criteria. Yet it causes several questions to arise: how might the creative thinking and problem solving abilities of pupils be enhanced, if such "training" were characteristic of a greater part of the pupils' school experience? How might such instruction be effectively integrated with other classroom instructional programs or innovative instructional arrangements (e.g., IPI or other individualized programs)? What new kinds of "training" are

possible, to affect more than the cognitive aspects of creative thinking? If creative potential is influenced by affective or emotional influences, motivational levels, social and cultural influences, and perhaps even by some skills and abilities in the psychomotor domain, how much more complex must both our instructional efforts and our criteria become (cf., Treffinger, Ripple, and Ferris,in press)?

Recommendations for Research

On the basis of this project, the following recommendations are offered for future research:

(1) One of the highest priorities for research in the area of creativity should be for the development and validation of new measures of creative abilities and problem solving.

(2) Research should be conducted in which training and assessment is provided which involves more than just the cognitive aspects of creativity and problem solving, particularly including provision for the affective and psychomotor domains and motivational variables.

(3) Research should be conducted in which the possible distinction between creative people who teach and teachers who foster creativity, and the validity of teacher TTCT test scores as predictors of facilitation of creativity in pupils, can be carefully examined.

(4) "Creativity training" does not take place in an environment which is constant or neutral; therefore, research involving the integration of such instructional efforts with differing educational milieu should be conducted, rather than focusing on further studies of the effects of specific instructional programs which constitute only a small portion of the educational experience for the pupils.

Summary of the Project

The effects of instruction in creative thinking and problem solving, active participation by teachers, teachers' level of divergent thinking ability, and distribution of instruction (four- and eight-weeks) were studied. Subjects were 793 fifth-grade pupils from 36 public school classes in two school systems in northern and central Indiana.

The Purdue Creativity Training Program (PCTP) and the Productive Thinking Program (PTP) were the instructional programs utilized. Teachers were classified as high or low on divergent thinking ability on the basis of a median split on scores derived from the Torrance Tests of Creative Thinking (TTCT). High and low groups were then assigned to particular program by time by participation combinations. Half the groups used the instructional programs over a four-week period, the other half over eight-weeks. Half used each program, and half were assigned to the active participation or discussion group. Four classes did not receive any instruction in creative thinking or problem solving.

Several criteria were used for assessing the effects of training and the specific instructional arrangements. Instruments included: The TTCT, given to all pupils before and after instruction; and two other tests, given as posttests, the Old Black House Problem and Problem Solving Number One. These instruments yielded a total of 14 criterion variables.

Data were analyzed separately for each criterion variable, using analysis of variance, Dunnett's t-test, and the Newman-Keuls procedure. If the over-all F-test, comparing control with all other groups was significant

($p \leq .05$), further analyses were conducted. The four-way ANOVA was conducted to compare experimental group means, followed by appropriate Newman-Keuls comparisons. Dunnett's t was used to compare each group mean with control.

Instructed pupils were generally superior to controls with respect to verbal fluency, flexibility, and originality, non-verbal fluency, three measures derived from the Old Black House Problem (number of ideas, quality of ideas, and attainment of solutions), and multi-solution anagrams.

For the eight-week PCTP groups, instruction was most effective with the higher divergent thinking ability teachers and active teacher participation. For the four-week groups, with both instructional programs, the most effective instructional arrangements were non-discussion and the lower teacher divergent thinking level. PTP groups, however, were generally superior to control groups, for both four- and eight-week groups, and with less influence of teacher participation or teacher's level of divergent thinking.

Three major problems were identified, pertaining to the difficulty of defining and verifying the treatments (particularly in relation to active teacher participation), the problems associated with the use of teachers TTCT scores as predictors of creative behavior in the classroom or the facilitation of pupil creativity, and the complexity of the construct of creativity, which may not have been adequately assessed in the criterion instruments or incorporated into the instructional programs. Implications for further research were identified.

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APPENDIX A:

THE OLD BLACK HOUSE PROBLEM

(Used and reproduced by permission of Dr. Martin V. Covington, University of California at Berkeley; copyrighted material.)

Your name _____ School _____

Your teacher's Name _____ Date _____

The Old Black House

It was said that gold was hidden in an old deserted black house far out in the country. So when the old house was broken into, a detective from the city went to investigate. After driving along the main highway from the city, the detective turned off onto a narrow road. He passed a lake and then a graveyard. Finally, he reached the black house, among some hills.

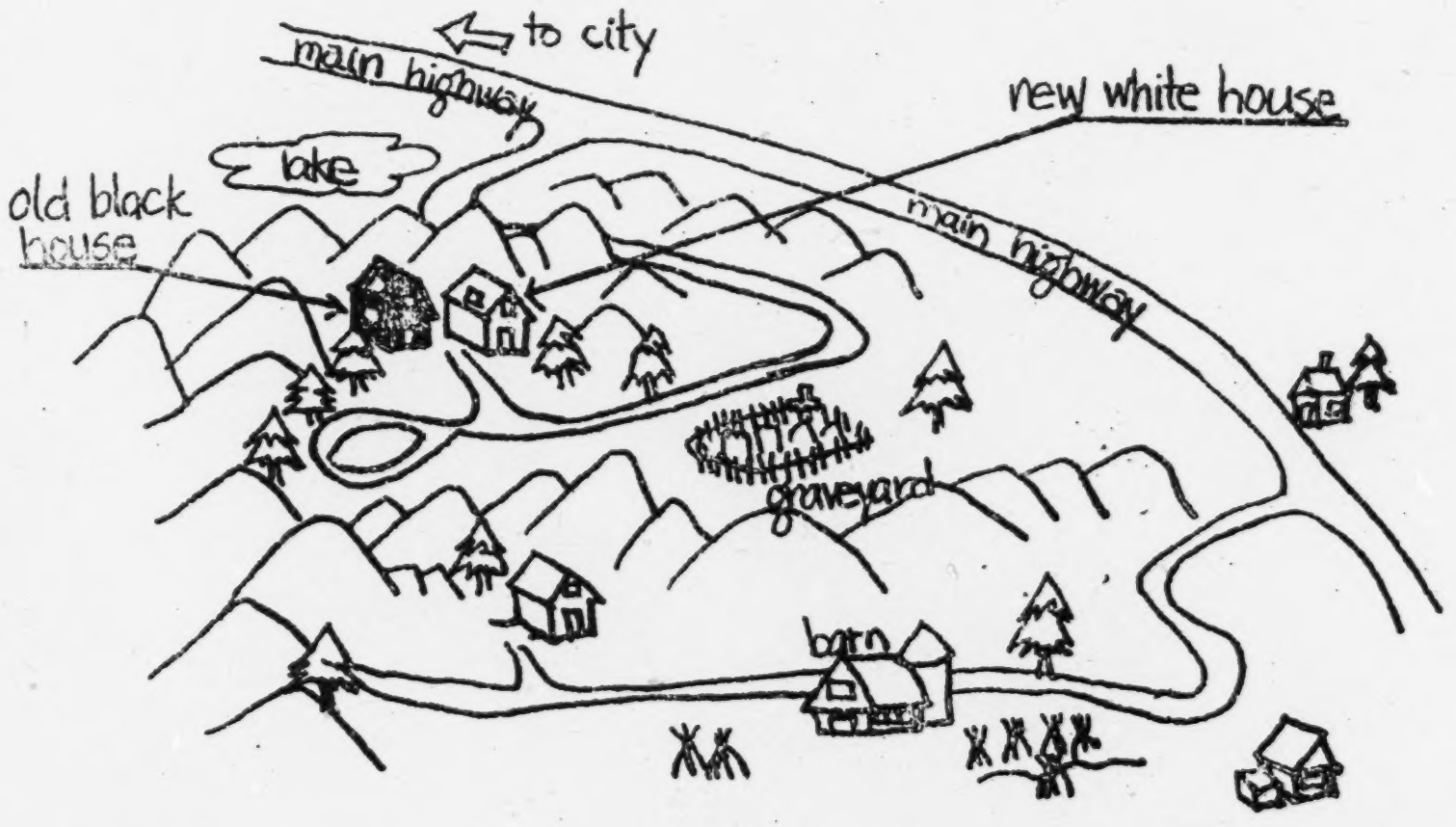
Next door to the black house was a newer, white house. It was one of several other similar houses in the area owned by a man named Mr. Round. Actually, Mr. Round was the one who had broken into the black house, looking for gold. He now figured out a plan to scare the detective away from investigating.

After the detective looked around inside the old black house, Mr. Round invited him to spend the night in the white house next door. The detective's room in the white house had only one small window, but he had a good view of the old black house and the sun setting behind it.

After dinner with Mr. Round, the detective felt very sleepy, so he went to bed. In the morning, after a deep sleep, the detective looked out of the small window and saw the sun rising. But the old black house was gone!!! He rushed outside and looked all around. Yes, the black house was gone, and there were no marks on the muddy ground.

Since the black house had disappeared, the puzzled detective decided to return to the city. He drove past a barn and then turned back onto the main highway to the city.

Here is the picture that goes with the story:



Now, see if you can solve this problem of the mysterious disappearance of the black house. You can read the story and look at the pictures as much as you want to.

As a first step, think of as many different ideas as you can for explaining how the black house disappeared. Write your ideas below. Number each idea as you go.

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Don't stop yet. Try to write down still more ideas for explaining how the black house might have disappeared. Especially include UNUSUAL ideas.

If you get stuck for more ideas, try to look at the problem in a different way.

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Go back and read the story again. Look for any odd or puzzling facts, besides the disappearance of the old black house itself. Write below any such odd or puzzling facts that you notice:

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Now think about the odd and puzzling facts which you may have discovered. Do they suggest any <u>new</u> ideas for explaining how the black house disappeared? If so, write your ideas below.

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

When you compare these two different parts of the story you may find something very odd and puzzling about them:

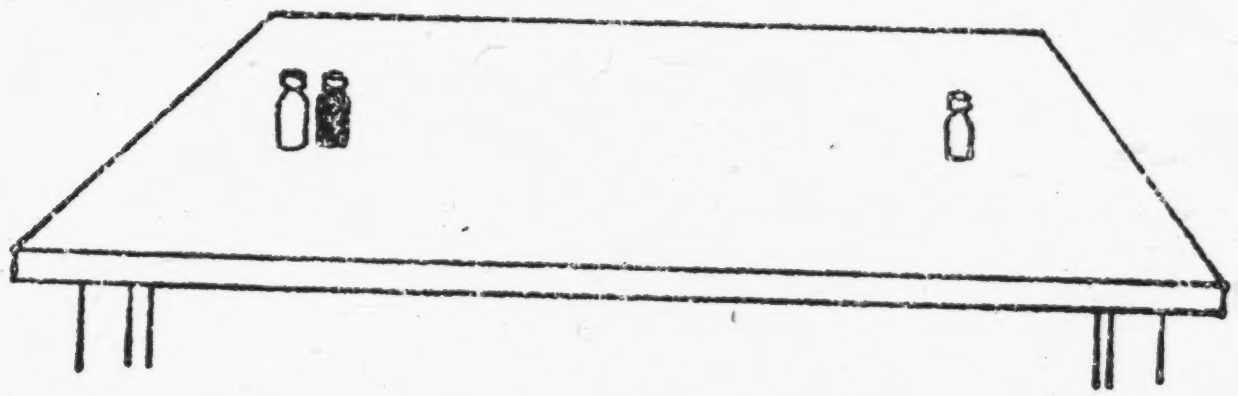
"After driving along the main highway from the city, the detective turned off onto a narrow road. He passed a lake and then a graveyard. Finally, he reached the back house, among some hills.....

"Since the black house had disappeared, the puzzled detective decided to return to the city. He drove past a barn and then turned back onto the main highway to the city."

Now do you have any new ideas for solving the problem? If so, write them below:

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Even after the detective returns to the city, he continues to think about the problem. While sitting in a restaurant he happens to notice two salt-shakers, one at each end of the table. Next to one of them is a pepper-shaker.



The detective suddenly looks excited. He had just been reminded of a possible answer to the mystery of the disappearing black house.

What is the solution the detective is thinking of? Write your idea here:

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Here are three facts from the story. Put a check mark in front of the <u>one</u> that you guess is the most important for solving the problem:

_____The fact that the ground was muddy.

_____The fact that there were trees nearby the black house.

_____The fact that the detective had a deep sleep during the night.

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

The most important of these three facts is that the detective had a very deep sleep during the night. This was after he had eaten dinner with Mr. Round.

Think about this fact, and then write down any new ideas you may have for solving the problem:

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Here are three more facts from the story. Put a check mark in front of the one that you guess is the most important for solving the problem:

_____The fact that there were hills around the black house.

_____The fact that Mr. Round owned several houses.

_____The fact that no one lived in the black house.

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

The most important of these three facts is that Mr. Round owned several houses.

Think about this fact, and then write down any further <u>new</u> ideas you may have for solving the problem:

_-------

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

The detective got the idea that something had been moved during the night. Put a check mark in front of the one thing that you think was moved:

_____The black house

_____The white house

_____The detective

Now write down any final ideas you have for solving the problem:

_____

_____

_____

WHEN YOU HAVE FINISHED, GO ON TO THE NEXT PAGE.

Here are some more things you might want to say about the problem. In each sentence put a line underneath one of the two possible answers; then complete the sentence to explain why you chose the answer you did.

I think the problem was (easy) (hard) because _____

_____

_____

I think the problem was (fair) (unfair) because _____

_____

_____

I think the problem was (interesting) (not interesting) because _____

_____

_____

I think the problem was (fun to do) (not fun to do) because _____

_____

_____

I think I would (like) (not like) to try more problems like this one,

because _____

_____

_____

APPENDIX B:

PROBLEM SOLVING NUMBER ONE

Multi-solution anagrams

Word fluency problem

Fighting on the Playground problem

Life at School Problem

SOLVING PROBLEMS (#1)

NAME _____

SCHOOL _____ TEACHER _____

1. Do not open this booklet until you are told to do so.

2. In this booklet, there are some problems for you to try to solve. We think you will have fun, thinking of many clever, unusual solutions for them.

3. Read the problem carefully, and then write down <u>all</u> the solutions you can think up. Number your answers for each problem.

4. If you wish, you may draw simple pictures to help explain your solutions.

5. Do not use any other paper; do any writing you need to do right in this booklet.

6. As you are working, you may go back to a problem that you have already worked on, but do <u>not</u> go ahead in the booklet. Wait until the directions are given before you go on to a new problem.

7. Try to find as many interesting solutions as you can for every problem.

Good thinking!

I. MIXED UP WORDS.

Here are some common words whose letters have been mixed up. Can you sort the letters? You may find that you can arrange the letters in several different ways for each part! (Each word you make must use all the letters.)

Example: Mixed up word: tno

Solutions: not
ton

(1) Mixed up word: ETOSV

Solutions: _____

_____

_____

(2) Mixed up word: AEBRD

Solutions: _____

_____

(3) Mixed up word: ONSE

Solutions: _____

_____

(4) Mixed up word: EQITU

Solutions: _____

_____

(5) Mixed up word: LSAET

Solutions: _____

_____

III. MAKING WORDS FROM ANTELOPES.

If we were to give a word like "WINTER" you could use some of the letters in it to make other words. For example, you could use the letters t, i, r, and e to make the word tire, or the letters w, i, and n, to make the word win--and lots of others. You could not make the word wind, because there is no letter d in WINTER. Also, you could not make the word tent, because it has two t's and there is only one t in WINTER.

Here is a word: ANTELOPES. Use the letter in that word to make up as many words as you can. Number your words.

III. FIGHTING ON THE PLAYGROUND

Not many schools have enough playground equipment for all the children to use during recess. As a result, sometimes children will fight with each other about using things.

List all the ways you can think of for solving this problem.

IV. LIFE AT SCHOOL.

We're sure that you know that pupils in school get restless once in awhile. Sitting at one's desk for many hours each day can get uncomfortable.

Just suppose that you could change school, so that you would be able to relax and be more comfortable, but still learn everything that you should.

Think up all the ways you can, to change school so that it would be more relaxed and comfortable.